Analysis of Salinity Intrusion in the San Francisco Bay-Delta Using a GA-Optimized Neural Net, and Application of the Model to Prediction in the Elkhorn Slough Habitat

David E. Thompson
NASA Ames Research Center, M.S. 269-1, Moffett Field, California 94035

T. Rajkumar
SAIC, NASA Ames Research Center, M.S. 269-1, Moffett Field, California 94035

The San Francisco Bay Delta is a large hydrodynamic complex that incorporates the Sacramento and San Joaquin Estuaries, the Suisan Marsh, and the San Francisco Bay proper. Competition exists for the use of this extensive water system both from the fisheries industry, the agricultural industry, and from the marine and estuarine animal species within the Delta. As tidal fluctuations occur, more saline water pushes upstream allowing fish to migrate beyond the Suisan Marsh for breeding and habitat occupation. However, the agriculture industry does not want extensive salinity intrusion to impact water quality for human and plant consumption. The balance is regulated by pumping stations located along the estuaries and reservoirs whereby flushing of fresh water keeps the saline intrusion at bay. The pumping schedule is driven by data collected at various locations within the Bay Delta and by numerical models that predict the salinity intrusion as part of a larger model of the system. The Interagency Ecological Program (IEP) for the San Francisco Bay / Sacramento-San Joaquin Estuary collects, monitors, and archives the data, and the Department of Water Resources provides a numerical model simulation (DSM2) from which predictions are made that drive the pumping schedule. A problem with DSM2 is that the numerical simulation takes roughly 16 hours to complete a prediction. We have created a neural net, optimized with a genetic algorithm, that takes as input the archived data from multiple gauging stations and predicts stage, salinity, and flow at the Carquinez Straits (at the downstream end of the Suisan Marsh). This model seems to be robust in its predictions and operates much faster than the current numerical DSM2 model. Because the Bay-Delta is strongly tidally driven, we used both Principal Component Analysis and Fast Fourier Transforms to discover dominant features within the IEP data. We then filtered out the dominant tidal forcing to discover non-primary tidal effects, and used this to enhance the neural network by mapping input-output relationships in a more efficient manner. Furthermore, the neural network implicitly incorporates both the hydrodynamic and water quality models into a single predictive system. Although our model has not yet been enhanced to demonstrate improve pumping schedules, it has the possibility to support better decision-making procedures that may then be implemented by State agencies if desired. Our intention is now to use our calibrated Bay-Delta neural model in the smaller Elkhorn Slough complex near Monterey Bay where no such hydrodynamic model currently exists. At the Elkhorn Slough, we are fusing the neural net model of tidally-driven flow with *in situ* flow data and airborne and satellite remote sensing data. These further constrain the behavior of the model in predicting the longer-term health and future of this vital estuary. In particular, we are

using visible data to explore the effects of the sediment plume that wastes into Monterey Bay, and infrared data and thermal emissivities to characterize the plant habitat along the margins of the Slough as salinity intrusion and sediment removal change the boundary of the estuary. The details of the Bay Delta neural net model and its application to the Elkhorn Slough are presented in this paper.